two plates. The number concludes with a "Comment on the 'Report of the Special Committee on the Lake Superior Region'" by Dr. Alfred C. Lane, stating why he "was willing to accept 'Laurentian' as a term apparently stratigraphic and coordinate with stratigraphic terms."

THE July number of the *American Geologist* contains a biographical sketch with portrait of the late 'Clarence Luther Herrick,' by Professor W. G. Tight. Dr. Ida H. Ogilvie contributes an article on 'The High Altitude Conoplain; a Topographic Form Illustrated in the Ortiz Mountains' of New Mexico. The conoplain is named and described as the plain sloping away from the Ortiz laccolith on all sides which has been partly built and partly cut. Professor W. O. Crosby publishes the first installment of an article on the 'Genetic and Structural Relations of the Igneous Rocks of the Lower Neponset Valley, Massachusetts,' which is stated to be an advance presentation, in outline, of a portion of 'the author's detailed and systematic study of the Geology of the Boston Basin.'

WE have received notice that in October next will be issued the first number of *The Journal of Biological Chemistry,* designed for the publication of original investigations of a chemical nature in the biological sciences, whether concerned with the phenomena of animal or of vegetable life. Without rigidly defining the scope of the *Journal,* it may be stated that its pages will be open (1) to workers in zoology and botany and the branches of knowledge in which these sciences are applied, for such of their researches as are of a chemical or physico-chemical nature; (2) to workers on the chemical side of the experimental medicinal sciences, as physiology, pathology, pharmacology, hygiene, physiological chemistry and bacteriology; (3) to those who are engaged in any branch of clinical medicine, when their researches are of a chemical nature; (4) to the specialist in organic chemistry, who will find here a fitting place for the publication of researches which have biological or medical interest. Contributors will be allowed prior publication of announcements or abstracts in other journals. Every legitimate effort will be made to bring the *Journal* to the notice of foreign readers and workers. At least six numbers will be issued yearly and will constitute a volume, each volume to contain between five and six hundred pages. The responsible editors will be John J. Abel, Baltimore, and C. A. Herter, New York. With them will cooperate as associate editors R. H. Chittenden, New Haven, Conn.; Otto Folin, Waverly Mass.; William J. Gies, New York; Reid Hunt, Washington, D. C.; Walter Jones, Baltimore, Md.; Waldemar Koch, Columbia, Mo.; J. H. Kastle, Lexington, Ky.; Graham Lusk, New York; Jacques Loeb, Berkeley, Cal.; P. A. Levene, New York; A. B. Macallum, Toronto, Canada; J. J. R. McLeod, Cleveland, O.; L. B. Mendel, New Haven, Conn.; F. G. Novy, Ann Arbor, Mich.; W. R. Orndorff, Ithaca, N. Y.; Thomas B. Osborne, New Haven Conn.; Franz Pfaff, Boston, Mass.; A. E. Taylor, Berkeley, Cal.; V. C. Vaughan, Ann Arbor, Mich.; Alfred J. Wakeman, New York; Henry L. Wheeler, New Haven, Conn.

DISCUSSION AND CORRESPONDENCE.

THE MUTATION THEORY.

THE paper by Professor White, beginning on page 105 of this volume, although, it seems to me, somewhat obscure in diction at times, as for instance near the bottom of the first column on page 109, where the expression 'rare genera' probably means isolated genera, is nevertheless most interesting and opens up many lines of thought and contemplation. There seems to be but little doubt that the main argument is wholly correct. The facts have of course long been known, and, in the Darwinian hypothesis relating to the origin of species by gradual evolution, an attempt is made to explain them by lost records or long time intervals of upheaval and denudation, the changes in species being gradually brought about in the meantime in some other region or environment. This assumption will not satisfy the long array of observed facts, however, especially in the case of land animals, and we are forced to adopt some such theory as that of

abrupt mutations in order to account for them. We are familiar with multitudes of cases where genera, orders or even classes seem to appear suddenly, but, as far as known to the writer, not a single instance where any considerable number of the minute morphological variations called for by the Darwinian theory in leading up to the new types, can be satisfactorily traced. It would appear, if the Darwinian theory were correct, that at least a few of the radical replacements by altered forms of life might be traceable by actual fossil remains in the underlying rocks.

The subject was very strikingly brought to my attention some time ago in studying the extensive family Pleurotomidæ of the gastropod Mollusca,—an important group, containing many genera and a vast array of species, which seems to come abruptly into being at the beginning of the Tertiary period. Some species supposed to belong to the family have been described from the upper horizons of the Cretaceous, but these are not sufficiently numerous or transitional in nature to affect the general truth of the above statement. Some of the better defined genera, such as *Gemmula,* appear abruptly in the earliest Eocene, in forms fully as well developed as those now living, and, in fact, some early Eocene species so closely resemble living shells that it is scarcely possible to distinguish them. There is not a particle of generic change, even in the complex embryo, from the time of their sudden appearance at the opening of the Eocene to the present time. Many genera, however, endure only until the end of the Eocene-Oligocene period, when there occurs again a rather universal and abrupt change of generic types.

At Vicksburg, Miss., appears a formation generally assigned to the Lower Oligocene, which may be resolved into two principal horizons, the lower of which is composed of fine light gray fossiliferous sand, with but little admixture of clay and alternating in thin strata with subequal thicknesses of more or less friable limestone, the upper consisting of an equally fossiliferous ferruginous red marl. In some places these two horizons are separated by a bed of blackish-gray compact clay, full of fossils which so closely resemble those of the upper marl that there can be but little question of its properly forming part of the upper horizon. These two horizons were probably separated by a time interval not very great, geologically speaking, possibly not more than a few thousand years—a relatively short time in the life history of most species,—during which the lower beds may have appeared above the ocean and have been subject to denudation until they were again submerged to receive the upper marls, the local conditions having changed somewhat in the interval, as shown by the different constitution of the beds as related above. In regard to the Mollusca of the two horizons, I find after a rather thorough exploration of both, extending over several years, that there is unexpectedly little in common between them. Probably not more than 40 per cent. of the species of either horizon are common to the two, and, in several instances, even these are at least varietally modified. There are, of course, a number of species of the lower beds represented by evident descendants in the upper marls, but what it is desired to lay particular stress upon in this connection, there are many widely divergent or wholly unrelated types appearing in the latter that are not even suggested in the former. Perhaps the exploration is not as yet sufficiently extended, but this is at least the present status of knowledge, with an equally thorough investigation of the two horizons as they are now exposed in the bluff at Vicksburg.

The mutation theory is evidently the best that has been advanced to account for these known facts. It should be especially acceptable to the theologians, also, as they maintain the spiritual and undying nature of man. If we conceive that man originated abruptly by some unaccountable molecular change in the ovum producing the original twins, Adam and Eve, there can be no doubt of the time when man became thus immortal, whereas there would be necessarily much uncertainty as to the time when this occurred among the successive infinitesimal increments of brain development necessitated by the Darwinian theory.

Born thus in the womb of the lower ani-

mals, man has become the most wonderful living thing on earth, separated by a great gulf from his next of kin, and yet, in spite of his high degree, afflicted with more diseases than any other animal and beset by at least as many tormenting parasites. Inexperienced in his early history, his mind steadily advanced until to-day he contemplates all nature with a yearning to know its mysteries. The changes in the germ-cell sufficing to evolve him are as inscrutable to his reason as the constitution of matter and the interstellar ether, the nature and origin of the cosmical forces and of chemical affinity, the conditions obtaining on other worlds revolving about untold millions of other suns, or the origin, nature and meaning of life itself. But we ardently desire to know these things, to peer out into unfathomable space and to speculate upon the meaning of our existence and the unknowable as we perceive it all about us in the universe. Under such circumstances are we to live but a short time on earth and then be consigned to everlasting oblivion? In contemplating the real significance of the word eternal or everlasting, which must refer to infinity—a duration of time so inconceivable that a number of years expressed in pica type encircling the entire globe would be as naught when compared with it—our reason would appear to answer in the affirmative. But, as a species—*sapiens*—of the genus *Homo*, we can never know. We seem to be but intellectual atoms floating in an infinity of space and time.

THOS. L. CASEY.

ST. LOUIS,
August 3, 1905.

SPECIAL ARTICLES.

THE SPEARMAN CORRELATION FORMULA.

SOME time ago C. Spearman published a formula for calculating the true correlation by the Pearson formula for observations in themselves variable.[1] This method has been used by several psychologists without a full understanding of the way in which Spearman arrived at the method. Such a use of the method is dangerous since those who apply it can not be accurately informed as to the conditions under which it holds.

Let

T represent the type.
σ represent the variability of the group.
t represent single observations upon individuals.
N the norm of the individual.
v represent the variability of the individual with respect to his norm, including the error of observation.

Assuming that all t's follow the exponential law and representing averages by [ ], we shall find in the long run that

$$[t] = [N] = T.$$

The observed variability of the group may be expressed as

$$\sqrt{\sigma^2 + v^2}$$

in which σ represents the true variability that determines the true correlation in the Pearson formula. The whole problem in practise is to find the value of v.

Spearman says that the true correlation may be obtained by dividing the average correlation for the various trials of the two tests by the square root of the product of the correlations for the successive trials for each test.

Let,

xy = the average product of the deviations for the corresponding single trials in two tests.
$(pq)_1$ = the same for t_1 and t_2 of the first test.
$(pq)_2$ = the same for t_1 and t_2 of the second test.
v_1 and v_2 = the true variabilities of individuals in the two tests.
σ_1 and σ_2 = the true variabilities as calculated for x and y.

Then by substitution in the formula of Spearman,

$$r^2 = \frac{[xy]^2}{\frac{(\sigma_1^2 + v_1^2)(\sigma_2^2 + v_2^2)}{(pq)_1 (pq)_2}}$$

$$r^2 = \frac{[xy]^2}{(pq)_1 (pq)_2}$$

Hence,

$$\sigma_1^2 \sigma_2^2 = (pq)_1 (pq)_2$$

$$\sigma_1^2 = (pq)_1$$

[1] C. Spearman, *American Journal of Psychology*, January, 1904.